

REGIONAL EQUITY AND THE GEOGRAPHIC  
DISTRIBUTION OF FEDERAL R&D FUNDS

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Working Paper

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This manuscript was prepared as a part of the research activity  
under grant NGR 26-004-012 between the Business and Public  
Administration Research Center, University of Missouri, and the  
National Aeronautics and Space Administration.

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September 8, 1967

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INTRODUCTION

In recent years, increasing public and political criticism has been directed at the effect of federal R&D expenditures on the regional pattern of the nation's research and development activities. Some indication of this dissatisfaction with the existing distribution is found, for example, in a statement by the president of the University of Wisconsin before the Senate Subcommittee on Employment and Manpower:

Failure to provide for geographical spread of Federal defense and space contracts has brought our Nation face to face with a most serious kind of overconcentration: overconcentration of our working scientists and engineers by region; overconcentration of our industrial and defense strengths by region.

. . . . . If these tendencies continue in the award of Federal research, development and production contracts, we are on the road to manpower chaos, economic chaos, social chaos, defense chaos. [17, p. 71]

Congressional interest in the distribution of federal R&D funds first developed out of a series of hearings on problems created by science and technology in the House of Representatives by the Daddario Subcommittee on Science, Research, and Development in October and November, 1963. As a result, the Subcommittee initiated hearings on the geographical distribution of federal R&D funds which were held in May and June, 1964, and issued a report on the subject in February, 1965. [14] This report established

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\*I am indebted to Mr. Gary K. Freerksen for his assistance in this study.

the existence of an uneven geographical pattern of federal R&D expenditures and recommended that corrective action be taken. A second study of the sectoral and regional implications of the R&D programs of federal agencies was published in December, 1964, by the House Select Committee on Government Research. [13] Additional hearings were held in the Senate in June and July, 1965, by the Subcommittee on Employment and Manpower [17] and in July, 1966, by the Subcommittee on Government Research [16].

Both Congress and President Johnson appear to be in agreement that the present geographical distribution of federal R&D funds is not satisfactory and that a more equitable pattern requires a more equal regional distribution of R&D funds. On September 13, 1965, President Johnson issued a policy memorandum to the heads of federal agencies and departments directing that "research supported to further agency missions should be administered not only with a view to producing specific results, but also with a view to strengthening academic institutions and increasing the number of institutions capable of performing research of high quality." [16, p. 5]

In the Senate two resolutions concerned with the regional distribution of federal funds were introduced in 1966. Senate Resolution 231 requests recommendations by the National Science Foundation about the changes that would be required in the laws governing expenditures by federal agencies and departments in order "to provide for a more equitable distribution of such funds to all qualified institutions of higher learning. . . ." [16, p. 1] Senate Concurrent Resolution 101 takes a somewhat broader and unusual position in support of a more equitable distribution of all federal funds that would serve to promote "a more orderly and equitable growth of the population of the various states. . .to the end that the problems of heavy concentrations

of population will be avoided or minimized in order that more opportunities for wholesome living will be available to more people." [16, p. 165 and pp. 166-167] Further Congressional agreement about the distribution of federal funds is indicated by the inclusion of a provision in the NASA Authorization Acts of fiscal years 1966 and 1967 stating that, when feasible, consideration should be given to the geographical distribution of federal research funds. [15, p. 8]

#### DADDARIO SUBCOMMITTEE REPORT

The report by the Daddario Subcommittee remains the most substantive statement of the issues surrounding the problem of the regional concentration of federal R&D funds and the solutions that have been considered by Congress. Thus a review of its findings and recommendations serves usefully to identify some of the implications of the problem as it has been viewed by Congress.

#### Geographical Patterns of Federal R&D Funds

Previously unavailable data describing the geographical distribution of federal extramural R&D funds awarded by federal agencies to performers were requested from the National Science Foundation by the Subcommittee. These data indicated an unequal geographical distribution of federal R&D for fiscal year 1963. The extent of the geographical concentration is summarized in Table 1. California, Massachusetts, and New York, the three states with the largest amount of R&D funds, accounted for 52 percent of the federal R&D funds; one-half the states received 97 percent of the funds.

Unequal patterns are also found when the state distribution of federal R&D funds is divided into distributions by performer and by sources (Table 1).

TABLE 1

Geographic Concentrations of Prime Contracts and Grants of Federal Extramural R&D Funds in States, by Recipient and by Selected Agencies, Fiscal Year 1963  
(In percentages)

Number of States with Largest Receipts of R&D Funds	Total	Type of Recipient			
		Profit Organizations	Educational Institutions	Nonprofit Organizations	Other Performers
One	38.6	40.8	28.7	15.1	32.6
Two	47.9	49.8	40.4	28.3	50.6
Three	52.5	53.9	48.9	33.4	65.2
Four	57.0	57.7	56.0	37.4	72.6
Five	60.5	61.5	62.0	41.2	77.6
Eight	70.1	71.1	73.6	51.3	87.7
Ten	74.9	76.5	77.5	57.2	89.6
Fifteen	85.1	86.4	84.2	69.2	93.6
Twenty	91.9	93.7	89.3	78.4	96.3
Twenty-five	96.7	97.9	92.8	84.7	98.1
Remaining States	3.3	2.1	7.2	15.3	1.9
Total	100.0	100.0	100.0	100.0	100.0
Percentage of Total Extramural R&D Funds	100.0	80.4	15.1	4.3	0.3

TABLE 1 (continued)

Number of States	Federal Agencies							
	DOD	NASA	AEC	HEW	NSF	Agriculture	Interior	Commerce
One	39.6	50.5	21.7	17.0	13.1	4.1	12.6	29.6
Two	50.7	58.7	40.0	28.4	23.8	7.9	22.8	40.5
Three	56.5	65.6	51.5	38.8	34.6	11.7	29.0	50.8
Four	61.3	71.2	60.8	45.5	41.5	15.5	34.2	58.7
Five	65.6	75.5	69.7	51.0	47.2	19.2	38.4	63.2
Eight	75.6	85.6	85.5	62.1	59.3	28.9	50.2	75.4
Ten	80.8	90.0	90.7	67.5	66.0	34.6	56.9	81.8
Fifteen	89.5	96.5	96.6	77.7	78.2	47.8	69.0	93.4
Twenty	93.9	98.5	98.6	85.5	86.7	59.6	77.0	97.2
Twenty-five	96.5	99.4	99.3	91.6	92.1	69.4	83.0	99.0
Remaining States	3.5	0.6	0.7	8.4	7.9	30.6	17.0	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percentage of Total Extramural R&D Funds	57.5	24.7	10.7	5.1	1.3	0.4	0.2	0.1

Source: House of Representatives, Sub committee on Science, Research, and Development, Geographic Distribution of Federal Research and Development Funds, 88th Cong., 2nd Sess., Figure 2 and Tables 1-5, pp. 7 and 56-65.



In both cases, sectors accounting for the largest percentages of federal R&D funds also tend to have the most unequal geographical distribution. In the case of performers, federal R&D funds awarded to profit organizations accounted for 80 percent of the total federal funds and were more unequally distributed than funds received by other performers, while nonprofit organizations with the most equal distribution received only 4 percent of the total R&D funds. In the case of R&D funds provided by federal agencies, DOD awarded 57 percent of federal R&D funds and together with NASA and AEC accounted for 93 percent of federal funds. At the same time, their funds were distributed more unequally than the R&D funds of other agencies. The R&D funds of the Agriculture and Interior Departments showed the most uniform geographical patterns, but they accounted for only 0.6 percent of federal R&D funds.

In general, performing sectors received most of their federal R&D funds from only a few agencies (Table 2). DOD was the major source of federal R&D funds for all but the other performers sector. DOD and NASA were the sources of 91 percent of the funds of profit organizations. On the other hand, DOD, NASA, AEC, and HEW contributed approximately equal parts of 90 percent of the federal R&D funds received by educational institutions.

Similar patterns are found in the funds awarded by federal agencies to performing sectors; more than 60 percent of the R&D funds of all but one agency were allocated to only one performing sector (Table 3). The Interior Department was the exception with a relatively uniform division of funds among the four performing sectors. Profit organizations received the major share of the R&D funds provided by DOD, NASA, AEC, and the Department of

TABLE 2  
Percent Distribution of Prime R&D Contracts and Grants  
Received by Performers from Selected Federal Agencies,  
Fiscal Year 1963

Federal Agencies	Total R&D Awards	Profit Organizations	Educational Institutions	Nonprofit Organizations	Other Performers
DOD	57.49	64.11	24.36	52.63	1.37
NASA	24.68	27.21	17.51	3.46	---
AEC	10.69	8.14	24.30	11.27	0.93
HEW	5.08	0.27	23.47	27.44	68.03
NSF	1.33	0.06	7.20	4.47	1.17
Agriculture	0.43	0.01	2.72	0.23	0.14
Interior	0.19	0.09	0.25	0.37	27.91
Commerce	0.12	0.11	0.19	0.14	0.45
Total	100.00	100.00	100.00	100.00	100.00

Source: House of Representatives, Subcommittee on Science, Research, and Development, Geographic Distribution of Federal Research and Development Funds, 88th Cong., 2nd Sess., 1965, Table 5, pp. 64-65.

TABLE 3

Percent Distribution of Prime R&D Contracts and Grants  
Awarded by Selected Federal Agencies to Performers,  
Fiscal Year 1963

Federal Agencies	Total	Profit Organizations	Educational Institutions	Nonprofit Organizations	Other Performers
DOD	100.0	89.73	6.37	3.89	0.01
NASA	100.0	88.73	10.67	.59	---
REC	100.0	61.29	34.20	4.48	0.02
HEW	100.0	4.26	69.51	22.95	3.28
NSF	100.0	3.71	81.74	14.33	.22
Agriculture	100.0	2.18	95.43	2.31	0.08
Interior	100.0	37.42	19.51	7.97	35.10
Commerce	100.0	70.99	23.23	4.88	.90

Source: House of Representatives, Subcommittee on Science, Research, and Development, Geographic Distribution of Federal Research and Development Funds, 88th Cong., 2nd Sess., 1965, Tables 1-5, pp. 56-65.

(Rows may not sum to 100 because of rounding.)

Commerce, while educational institutions received 70 percent or more of the R&D expenditures of HEW, NSF, and the Department of Agriculture.

These data describe only the location and value of prime R&D contracts and awards. In order to consider the effect of subcontracting on the distribution of federal R&D funds, the Subcommittee requested information on the first-tier subcontracts from the ten largest prime contracts awarded in fiscal year 1963 by each agency. These data were received from 6 agencies for 60 prime contracts awarded in 21 states.

First-tier subcontracts were placed in 43 states, however only 2.5 percent of the total funds went to states not included in the original distribution. The first-tier subcontracts resulted in a more equal geographical distribution of R&D expenditures, but the redistribution tended to take place within the same number of states (Table 4). Because of the resulting changes in funds received by individual states, the Subcommittee concluded that the subcontracting process significantly complicates the attempt to determine regional effects of federal R&D prime contracts. [14, p. 19] This conclusion must be tempered somewhat in view of the tendency for subcontracts to follow the same geographical pattern as the original expenditures.

#### Analysis of the Relationships between State Characteristics and the Distribution of Federal R&D Funds

The attempt to relate a number of state characteristics with the geographical R&D data represents a noteworthy contribution of the Daddario report. The state characteristics include population, number of industrial employees, federal tax contributions, number of scientists, advanced degrees conferred, and university and college enrollment. They appear to serve the Subcommittee both as a measure of differences in research capability, and thus of the

TABLE 4

Geographic Concentrations of 60 Prime Contracts and Grants and Resulting Distribution after Considering First Tier Subcontracts, Fiscal Year 1963  
(In percentages)

Number of States with Largest Receipts of R&D Funds	Prime Contracts and Awards	Net R&D Funds after First Tier Subcontracts
One	44.7	40.4
Two	57.8	49.1
Three	66.2	57.4
Four	72.3	64.5
Five	75.9	69.2
Eight	85.4	79.5
Ten	90.2	84.2
Fifteen	99.6	94.0
Twenty	99.9	98.4
All Remaining States	0.1	1.6
Total	100.0	100.0

Source: House of Representatives, Subcommittee on Science, Research, and Development, Geographic Distribution of Federal Research and Development Funds, 88th Cong., 2nd Sess., Figure 10, p. 18.

determinants of the distribution of R&D funds [14, pp. 8-16], and as indicators of an equitable distribution of federal R&D funds among regions [14, p. 49].

In order to judge the relative usefulness of the state characteristics for explaining the state distribution of R&D funds, state ratios of R&D and each characteristic are compared with the geometric mean of the ratios for all states and with the national ratio. This procedure yields a somewhat qualitative indication of the relationship between R&D and the state characteristics. In order to get a more specific measure of the correlation between the variables, Spearman rank correlation coefficients have been computed for each relationship. [12, pp. 202-212]

The state distribution of federal R&D funds was compared with the state distributions of population, federal tax contributions, and scientists. The report concluded that federal tax contributions, population, and number of scientists are each successively more highly correlated with federal R&D funds. [14, pp. 12-13] A comparison of rank correlation coefficients of .73, .70, and .81, respectively, indicates essentially the same results.

The state distribution of industrial employees was compared with the state distribution of federal R&D funds received by profit organizations and was considered not to be an important factor in determining the distribution of these funds. [14, p. 11] In this case, the rank correlation coefficient has a value of .53, also indicating a relatively low correlation between the two variables.

Finally, the state distribution of federal R&D funds received by educational institutions was compared with the state distributions of scientists in educational institutions, number of university and college students, and number of advanced degrees conferred. The report concluded that the

distribution of federal R&D funds awarded to educational institutions was both highly and approximately-equally correlated with these three independent variables [14, pp. 13-17], and the corresponding rank correlation coefficients of .88, .84, and .84 tend to support these results.

#### Subcommittee Findings and Recommendations

Based on their investigations, the Subcommittee found the existing geographical distribution of federal R&D funds to be "vastly unequal" and agreed that a more equal distribution was required to reduce the "degree of inequity" associated with the existing distribution. [14, pp. 48-49] They further suggested the geographical distributions of population, industrial employment, scientists, advanced degrees, and student enrollment as possible norms against which to determine a more equitable and thus a more equal distribution of federal R&D funds among states. [14, p. 49]

Some confusion exists in concepts involved in the Subcommittee's consideration of the equitable treatment of regions with respect to the distribution of R&D funds. On the one hand, a more equitable distribution of federal R&D funds is viewed as a means of overcoming regional disparities in the level and growth of economic activity, the quality of colleges and universities, and the utilization of trained scientific and technical manpower. [14, pp. 51-52] On the other hand, their report implies, for example, that the distribution of R&D funds should be related to "the population and educational distribution" among regions. [14, p. 50]

The subcommittee concluded that steps taken to distribute federal R&D funds should not degrade attempts by federal agencies to achieve national goals [14, p. 51] or detrimentally affect regions and institutions favored by the existing distribution of R&D funds. [14, p. 48] Within these constraints, the report recommends, first, the identification and use of

existing scientific and technical capabilities in less favored regions and, second, the development of new scientific capabilities by the provision of additional funds for research and facilities at institutions with a strong potential for becoming centers of excellence. [14, pp. 53-54] For the most part, these recommendations appear to be directed at educational institutions.

#### ASPECTS OF THE PROBLEM OF REGIONAL EQUITY IN THE DISTRIBUTION OF FEDERAL R&D FUNDS

Expenditures by federal agencies generally relate to their particular missions and, in turn, to one or a few national goals. The allocation of funds for one purpose yields benefits in terms of the greater achievement of particular goals and costs in terms of the reduced achievement of other goals. The total federal expenditure process can be viewed as the attempt to achieve an efficient allocation of a given budget in the sense of maximizing the net gains in terms of a hierarchy of national goals.

Here, spatial aspects are only implicitly involved in the allocation problem. A particular spatial allocation of funds is implied in the efficient use of the budget. Given the hierarchy of national goals, a departure from this spatial allocation comes at the cost of a reduction in overall benefits. Thus, if consideration is given to regions in the allocation process because of regional constraints placed on the use of the budget or priority given to regional goals in the hierarchy, the effect can be judged in terms of the resulting additional benefits and costs in the overall achievement of national goals.

In fiscal year 1965, 15 percent of the federal budget was devoted to R&D activity. [7, p. 4] R&D expenditures can be judged as an alternative use of the budget in terms of their net contribution to the achievement of



national objectives. In practice, federal agencies consider R&D activities as only one of a number of alternative ways of attaining specific agency missions. DOD, NASA, AEC, and HEW were the source of 96 percent of federal R&D funds in 1965. [8, p. 27] Thus, the major part of federal R&D expenditures are directed primarily at the missions of these agencies and only secondarily at other national goals affected by R&D activity. For the most part, only NSF has direct responsibility for encouraging the expansion of the nation's scientific and technical capabilities; in 1965, it accounted for 1.2 percent of federal R&D obligations [8, p. 76].

#### The Spatial Allocation of Federal R&D Funds

The net benefits realized from federal R&D expenditures depend, like other federal expenditures, on their positive and negative influence on the achievement of national goals and on the priorities attached to these goals. An efficient allocation of R&D funds implies some spatial allocation of these funds. The opportunity cost of an alternative geographic pattern of R&D funds is measured by a lesser achievement of the set of national goals. A reallocation of a given R&D budget among regions might be advantageous only if the existing regional allocation of R&D funds is inefficient or if a change occurs in the relative priorities attached to national goals.

Some critics have suggested in effect that the existing uneven distribution of federal R&D funds is explained in part by an inefficient spatial allocation of R&D funds. They contend that federal agencies have underestimated the scientific capabilities of institutions in some regions, particularly the Midwest, and that this has resulted in a misallocation of federal R&D funds [See, for example, 17, p. 544]. The misallocation has

been attributed to both the contracting procedures of federal agencies and inadequate communications between the agencies and potential R&D performers [17, pp. 8-10]. Although agency officials generally assert that the best available scientific and technical resources are utilized in agency programs, several agencies have responded to this problem by holding regional conferences designed to acquaint potential performers with agency R&D requirements.

A similar argument often made in support of a more uniform regional distribution of federal R&D funds is that the less favored regions possess substantial underutilized R&D capabilities. In this case it is argued that a geographic redistribution of federal R&D funds could be effected by the allocation of additional funds in these regions. Still assuming a given hierarchy of national goals, an efficient regional allocation of additional R&D funds would depend on the character and purpose of the additional R&D expenditures in relation to the distribution of R&D capabilities. The efficient use of additional funds might result in a greater concentration of expenditures.

At any given time the regional distribution of federal R&D funds is constrained by the location and quality of scientific capabilities in industrial, university, government, and private institutions. Even over a longer period of time, the ability of federal agencies to influence the location of R&D activity is somewhat limited. They are perhaps least restricted in decisions about the location of R&D performed in government laboratories and federal contract research centers, which accounted for approximately 29 percent of federal R&D funds in 1965. However, even in this case, the existence of strong agglomeration economies might favor their location in areas with high R&D concentrations.

The regional distribution of R&D funds to industrial, educational, and private research organizations depends to a much greater extent on the existing R&D capabilities in these organizations. More than 60 percent of the federal funds go to industrial organizations yet they tend to be concentrated in fewer regions than other performers. Educational institutions are spread more evenly; however, they receive only 8 percent of the federal R&D funds in 1965.

A geographic redistribution of federal funds may become desirable as the result of priority changes within the hierarchy of national goals or the consideration of regional goals. In recent years, for example, increased emphasis appears to have been placed in the research programs of federal agencies on the development of science education. In response to the President's September, 1965, memorandum "Strengthening Academic Capability for Science Throughout the Country," basic research funds awarded to educational institutions in fiscal year 1967 are expected to increase 10 percent, while support in many other areas is expected to fall [7, p. 11]. The allocation of R&D funds by federal agencies has also been affected by requirements that agencies consider the effects of their R&D policies on small business, the gold supply, labor-surplus areas, and, as we have seen here, the regional equitableness of the distribution of R&D funds.

### The Equitable Treatment of Regions<sup>1</sup>

The general notion that federal expenditures should be distributed either equitably or more equitably among regions is not, as such, a very

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<sup>1</sup>This section benefits from the discussion of the concept of equity in a paper by Reiner [11] on the use of regional allocation criteria in regional and national planning.

useful guide for the spatial allocation of government expenditures. In this context, the idea of the equitable treatment of regions may be viewed as an allocation of federal funds designed to achieve an equal regional accomplishment of one or more objectives or goals. As with national goals, regional goals are likely to be assigned different priorities according to the values of decision makers, so that they occupy various positions in a hierarchy of goals. When more than one goal is considered and regional equity is measured in terms of the effect of federal expenditures on a hierarchy of goals, regional equity may exist even though disparities occur in the achievement of specific goals among regions. The benefits and costs of the greater achievement of any one objective, then, are measured in terms of the resulting positive or negative influences on the achievement of other regional and national goals.

Some confusion between the concepts of equity and equality almost inevitably seem to creep into discussions of the equitable treatment of regions. An equitable distribution of federal funds will not necessarily be an equal regional distribution. An equitable distribution has been defined as a distribution that involves an equal regional achievement of a hierarchy of objectives. In most cases, the regional distribution of federal funds needed to correct existing disparities among regions is likely to be an unequal distribution that is biased toward the less favored regions.

The concept of an equitable regional distribution of federal funds in any given time period depends on the target date for attaining regional equity. In a given time period, then, an equitable distribution of federal funds may be one that results in an equal regional achievement of a hierarchy of regional goals, one that leads to gradually greater equality,

or one that prevents greater inequality [11, p. 116]. The notion of an equitable distribution of federal funds may also include the requirement that no region should be made worse off or that each region should be assured at least a minimum achievement of the hierarchy of goals. Under these circumstances, an equal or a more equal regional allocation of federal funds might represent an equitable allocation in a particular time period.

Regional equity may be attained among regions; however, such an equitable allocation of federal funds may result in greater inequality in the achievement of a hierarchy of goals among areas and sectors within regions [11, p. 115]. The question of equity in areas within regions may be considered by the analysis of smaller regions [11, p. 115]. In the latter case, however, the notion of regional equity would need to be modified to include the influence of federal funds on individual sectors within regions.

The indices chosen as measures of the achievement of various regional goals also affect the notion of the equitable distribution of federal funds. For example, the rate of growth or the level of income, production, employment, or population might be used as a measure of economic growth in regions. The results are also influenced by whether the indices are expressed as a measure of central tendency, such as average income, or in terms of the distribution among sectors in the region [11, p. 114].

#### Regional Effects of Federal R&D Funds

The concern shown by Congress about the question of the equitable allocation of federal R&D funds among states is paralleled by, and is in part the result of, an increasing competition among states and regions for

science-oriented industry and government research installations. This phenomenon, which rather aptly has been termed "the seduction of science" [4], appears to stem from the conviction that science is the "key to progress and prosperity" for states and regions [4, p. 39]. Increased R&D activity is recognized as a source of benefits comparable to those of new industry, but, more importantly, as a means for upgrading universities, raising standards of living, and attracting new industry. In view of the feeling that R&D activity is capable of leading to the social and economic rejuvenation of a region, it is not surprising to find a considerable amount of competition among regions for government research facilities such as the National Center for Atmospheric Research and the NASA Electronics Center.

There appears to be considerable agreement that the present regional allocation of federal R&D funds is inequitable and that a more equal distribution of R&D funds is necessary for achieving regional equity. This agreement does not extend, however, to the question of which indices are to be used for determining the regional allocation of R&D funds or the degree of equality that is required.

At one extreme, the position is taken that the regional allocation of funds should be determined by the location and quality of scientific and technical capabilities. This position is modified somewhat in another suggestion that a portion of the funds be allocated according to capability and the remainder allocated in proportion to indices such as college-age population, per capita income, and the contribution made by the various states [13, p. 93]. The Daddario report presents a more general position that some indication of equity is given by a number of indices, including

population, industrial employment, scientists, student enrollment, and advanced degrees awarded [14, p. 49]. Others have suggested that R&D funds should be allocated so as to achieve "approximately equal development of all geographic areas in relation to their population and their competence" [17, p. 11] or that R&D funds be allocated strictly in proportion to population [17, p. 224].

These allocation criteria do not appear, in some cases, to distinguish adequately between the effect of federal R&D expenditures on regional equity as opposed to other national goals. In most cases, measures of scientific capability are related to the achievement of national goals; the opportunity cost of pursuing the objectives involved in regional equity is the lesser achievement of the hierarchy of national goals.

Although the need for an equitable distribution of R&D funds among regions is generally accepted, this distribution cannot be completely defined. However, an indication of a number of its characteristics can be found in Congressional hearings and reports.

In general, the conclusions of the Daddario report appear to represent the views that have been presented in other areas and so are still relevant [14, pp. 48-54]: The present distribution is inequitable; greater equity will require a more equal distribution of federal R&D funds among regions. A change in the distribution of R&D funds should not make any region or institution worse off nor should it reduce the extent of achievement of agency missions. A more equal distribution of federal R&D funds necessitates an expanded and more uniform spatial distribution of R&D capabilities. This presumes, in general, the full utilization of R&D capability and the efficient allocation of federal R&D funds. Given these assumptions and the above

constraints, a more equitable distribution of federal R&D funds requires the use of additional funds to expand R&D capabilities in relatively less-favored regions. While this procedure serves to maintain the existing level of achievement of national goals, the opportunity cost of the additional funds used for regional equity is the additional achievement of national goals foregone because of this use of the budget.

These conditions restrict the steps that can be taken to achieve a more equitable distribution, but they do not offer the regional objectives needed for determining the distribution itself. In general, discussions of regional equity with respect to the distribution of federal R&D funds have appeared to focus on the effects of R&D funds on regional patterns of economic activity and higher education. In this sense, the attempt to achieve a more equitable distribution of R&D funds would involve a reduction of regional disparities in the level of economic activity and the availability and quality of higher education. This, in turn, implies a more equal distribution of federal R&D funds. Unless unused R&D capabilities already exist in the appropriate regions, a more equal distribution of federal R&D funds must be achieved by the use of R&D funds to expand the geographic distribution of scientific capabilities. Given the constraints discussed above, a more equitable distribution of federal R&D funds is achieved by allocating an additional amount of R&D funds inversely with the regional distributions of economic activity and higher education.

The resulting geographic distribution of federal R&D funds depends on the priorities attached to the two objectives subsumed in the goal of regional equity. There is ample evidence that, in effect, the expansion and improvement of higher education has been given the higher priority.



This ranking is stated explicitly in the report of the Select Committee on Government Research [13, p. 117]. The Senate Subcommittee on Government Research conducted hearings in 1966 on the "Equitable Distribution of R&D Funds by Government Agencies" [16] in connection with the introduction of Senate Resolution 231. The hearings were devoted almost entirely to the effects of the regional distribution of federal R&D funds on institutions of higher learning; the resolution associates a more equitable distribution of R&D funds to academic institutions with the objective of reducing geographic disparities in scientific and academic activities and in the level and skills of scientific and teaching manpower [16, p. 1]. Finally, President Johnson's memorandum of September 13, 1965, directed that the R&D funds of federal agencies should be allocated nationally to achieve the best results but also to achieve a more equal geographic distribution of the number and quality of academic institutions capable of performing research [16, p. 5]. NASA, DOD, HEW, and NSF all have programs to encourage the regional expansion of scientific and academic capabilities [7, p. 11], but give little consideration in their allocation of R&D funds to regional economic activity.

As a rather fascinating aside, an alternative formulation of the concept of an equitable distribution of federal R&D funds is presented in Senate Concurrent Resolution 101. Here, a more equitable distribution of federal R&D funds is one that leads to smaller concentrations of population and thus to a greater availability of "opportunities for wholesome living" [16, pp. 165-167]. According to this approach, federal funds would be allocated inversely with the size of population centers in order to reduce regional disparities in the achievement of wholesome living.

The application of the concept of regional equity involves the view that federal R&D funds represent a viable means for promoting regional

economic development and increasing the availability and quality of higher education in various regions. Presumably, this second aspect of the influence of federal R&D funds is to be considered as having a higher importance or value. The importance of the concept of regional equity as it is applied to the distribution of federal R&D funds depends, first, on the magnitude of the expenditures that are involved and, second, on the effects that these expenditures can have on the achievement of the regional objectives.

Federal R&D funds accounted for 65 percent of the \$17.4 billion of R&D performed in 1963 [9] and the \$23 billion of R&D performed in 1966 [3]; however, the total R&D performed represented only 3 percent of the gross national product in each year. In recent years, federal R&D funds have accounted for roughly 15 percent of the budget [3]. The influence of the regional distribution of federal R&D expenditures cannot be considered independently of the distribution of other kinds of federal expenditures. In two recent studies by Weidenbaum [18, 19], the regional distributions of various kinds of federal expenditures are compared with the regional distribution of income. In general, he found space and defense expenditures to be distributed less equally than income and domestic civilian programs to be distributed more equally than income [19]. R&D expenditures by NASA, DOD, and NSF are also distributed less equally than income [18]. In this case, a more equal distribution of income would tend to result from either a decrease in R&D expenditures or an increase in a nondefense expenditure.

Decisions by federal agencies about the location of government research facilities and federal contract research centers have, at times, resulted in a more equal distribution of federal R&D funds. The standard case of this is the establishment of several NASA facilities in Southern states.

However, attempts to achieve a more equitable distribution of R&D funds, as such, appear to have been limited for the most part to the more equal distribution of federal R&D funds to universities and colleges. Paradoxically, in fiscal year 1965, universities and colleges proper receive only 8 percent of the federal R&D funds and these funds were more evenly distributed than for any other performer [8, 20-21]. Some perspective is gained from the fact that these R&D funds are roughly only 1.3 percent of the federal budget and 0.2 percent of the gross national product [17, p. 41].

We have seen that the notion of regional equity involves a more equal distribution of federal R&D funds designed to lessen regional disparities in the achievement of goals involving regional economic development and higher education. This assumes that the increase in R&D expenditures takes place and that it has the desired effects. In order to determine the extent to which such assumptions can be accepted, it is useful to examine the effects that R&D expenditures can have on regional economies and universities.

#### Regional Economic Development

The effects of R&D expenditures on the level of income or employment in a community or region can be divided into direct and agglomeration effects. This classification is quite similar to what could be used to consider the effects of any new firm and, in fact, has been used by the author for this purpose [1].

The direct effect includes the income and employment associated directly with the R&D expenditures plus the multiplier effects on income and employment of additional local consumption expenditures and local expenditures for R&D materials that may also be associated with the R&D expenditures.

The agglomeration effect includes the income and employment of new R&D facilities and firms that may be attracted to the region as a consequence of the R&D expenditures. The new facilities may find the region to be an advantageous location because of the potential realization of agglomeration economies resulting from the R&D expenditures [2, 6]. In addition, the acquisition of federal R&D contracts in a region may lead to future procurement awards. This proposition is supported by a study of DOD research and procurement awards which shows that the state distribution of procurement awards is strongly correlated with the placement of research contracts among states in earlier years [5].

The magnitude of the economic effects of federal R&D expenditures depends on the character of the work and the performer. The effects of federal R&D funds awarded to universities are likely to be limited, for the most part, to the income of R&D personnel and the accompanying multiplier effects. Sizeable agglomeration effects are unlikely; a number of studies have indicated that the location of industrial R&D facilities is not affected significantly by the existence of a university [6; 13, pp. 20-21].

Federal R&D funds used in government laboratories, contract research centers, or industrial research facilities may result in local expenditures for materials and supplies in addition to salaries paid to R&D personnel. This would mean a relatively larger direct effect than in the case of a university. There is a possibility that suppliers or other research installations might be attracted to the region or that, primarily in the case of industrial performers, the research awards might lead to future procurement awards.

Substantial regional economic growth as the result of federal R&D expenditures is the exception. The remarkable economic growth of Huntsville, Alabama, and Tullahoma, Tennessee, for example, came as the result of very large federal R&D expenditures. The placement of R&D awards in previously low-R&D regions is likely, in most cases, to have a relatively small influence on regional economies.

One of the objectives of a more equitable geographic allocation of federal R&D funds is the reduction of disparities in economic development among regions. There is little indication that federal R&D expenditures are a particularly effective way of generating regional economic growth. In any case, federal R&D funds to universities are likely to be even less effective in this respect than funds to other performers.

#### Higher Education

The second and perhaps more important objective for accomplishing a more equitable distribution of federal R&D funds is the achievement of a more uniform distribution of high-quality educational institutions among regions. In this case, the redistribution of federal R&D funds awarded to universities and colleges are expected to expand and improve the quality of higher education in various regions.

In 1963, universities and colleges performed 7 percent of the nation's R&D activity, however, more importantly, they performed 19 percent of the nation's research and 41 percent of its basic research [9].<sup>2</sup> On the other

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<sup>2</sup>Because we are interested in research activities in educational institutions, as such, the R&D activities of federal contract research centers administered by universities are not included. Although they performed 3 percent of the nation's R&D in 1963, they have very little influence on the academic aspects of universities [8, p. 24].

hand, basic research, applied research, and development were 79, 18, and 3 percent, respectively, of the total R&D performed by universities and colleges in 1964 [10].

The federal government plays a significant role in funding research activities in educational institutions. Although federal R&D funds to educational institutions represented only 8 percent of the total federal R&D funds, the federal government was the source of 72 percent of the R&D funds of universities and colleges in 1964 [10]. HEW is the leading agency in support of educational R&D activity; it is followed by DOD, NSF, and NASA. Federal R&D funds represent only about one half the total federal funds provided to universities and colleges [16, p. 69] which, in turn, represent 22 percent of the total expenditures of educational institutions [16, p. 104].

Although federal R&D funds awarded to educational institutions are more evenly distributed among regions than for any other performer, they are still fairly concentrated among regions and institutions. In 1965, 3 and 10 states received 37 and 65 percent, respectively, of the federal R&D funds provided to educational institutions; 20 educational institutions accounted for 36 percent of these federal R&D funds [8, p. 21]. The regional distribution of federal R&D funds in educational institutions is highly correlated with the distributions of various measures of scientific capabilities, including scientists, graduate enrollment, Ph.D. awards, and federal contract applications [8, pp. 21-24; 16, pp. 71-72]. Thus regional disparities in the level of federal R&D funds to educational institutions appear to result, in large part, from the unequal regional distribution of scientific and research capabilities in these institutions.

The primary goal involved here is the problem of expanding and improving academic institutions. A more equal distribution of federal funds for academic research is likely to contribute to strengthening higher education. However, there are likely to be other, perhaps equally or more effective, ways to stimulate quality, such as the expansion of library holdings, the attraction of first-rate faculty, or the construction of new facilities.

#### SUMMARY AND CONCLUSIONS

Since 1963, the geographic distribution of R&D funds by federal agencies has been criticized both within and out of the federal government. The result has been a rather general agreement that the present distribution of federal R&D funds is both unequal and inequitable. The question of inequity and measures to achieve a more equitable distribution have been discussed in a number of Congressional hearings, reports, and resolutions and a Presidential memorandum.

The first part of this paper reviews the issue of regional equity as it evolved in the various Congressional hearings and reports on the regional distribution of federal R&D funds. Particular attention is given to the Daddario Subcommittee Report. Although it first became available in October, 1964, the report represents a fairly compact statement of most of the issues that have been raised in Congress as well as the first available data describing the regional distribution of federal R&D funds and a number of conditions that should be considered by the concept of equity. A number of difficulties remained: the concepts of equity and the equitable distribution of federal R&D funds were left unsettled, and the concepts of efficiency, equity, and equality in relation to the distribution of R&D funds were sometimes interchanged.

The second part of this study first develops a framework within which to consider the implication of national goals for the spatial allocation of federal funds. Regional equity is defined as the equal achievement of a hierarchy of objectives by the various regions. The question of the equitable distribution of federal R&D funds is then examined in this context. It is suggested here that the concept of a more equitable distribution of federal R&D funds has come to mean a distribution of R&D funds that can lead to smaller regional disparities in the level of economic activity and the quality and availability of higher education. In practice, attempts to achieve regional equity have been limited to the federal R&D funds awarded to educational institutions. These funds account for a very small portion of the federal budget. Therefore, in any case, the opportunity cost of regional equity in terms of the lesser achievement of other national goals is likely to be slight. On the other hand the benefits may also be small.

An examination of the potential effects of R&D expenditures on the regional economic activity and academic institutions indicates there are likely to be more effective ways of achieving these regional objectives than the redistribution of federal R&D funds. This conclusion is reached less strongly in the case of higher education than regional development.



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